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STUDENT REPORT

MILITARY MAN IN SPACE:
A HISTORY OF AIR FORCE EFFORTS
TO FIND A MANNED SPACE MISSION

MAJOR TIMOTHY D. KILLEBREW 87-1425

"insights into tomorrow"

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Traces the Air Force's efforts to find a manned military space role. Begins with the development of Dyna Soar shortly after World War II. Traces Dyna Soar's evolution and political problems that caused its eventual cancellation. Discusses the Manned Orbiting Laboratory from its beginnings in 1963 until its cancellation in 1969. Gives the potential uses of the Manned Orbiting Laboratory and the reasons behind its cancellation. Traces the beginnings of the Space Transportation System and the reasons behind the Air Force's decision to use STS as the sole means of entering space. The study concludes with a short discussion on the future of Air Force manned space efforts including a follow-on to the Space Shuttle and the probability of a Space Station.

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PREFACE

This is a history of the Air Force's efforts to obtain a permanent manned presence in space. When I started this paper, I believed that the Air Force would undertake manned space operations in the near future and that this was necessary for the national security. Although a military manned spacecraft other than the Space Shuttle may eventually be orbited, I am now uncertain of the need for it. I am not alone in this uncertainty. Many Air Force leaders have had the same misgivings during the past four decades since the Air Force began its push into space. It is this uncertainty and the need to resolve it that is addressed in this paper.

I wish to thank Mr. R. Cargill Hall of the USAF Historical Research Center for guiding me to the information sources needed to complete this project, for ensuring that I made the paper historically correct, and for critiquing the finished product.

I also wish to thank my wife, Gayle, for her able assistance in editing the finished product. Her help, understanding, and support were important to completing this effort.

ABOUT THE AUTHOR

Major Timothy D. Killebrew (USAF) is a senior navigator with over 2,000 hours flight experience in the T-29, T-43, and C/EC/KC-135 aircraft. He was commissioned through Officer Training School in 1974. After graduating from Undergraduate Navigator Training at Mather AFB, California, in April 1975, Major Killebrew was assigned to the 305th Air Refueling Wing, Grissom AFB, Indiana, where he served as an instructor and evaluator navigator. Beginning in 1980, Major Killebrew served in Strategic Air Command's 1st Combat Evaluation Group as an evaluator. Following this two year tour, he was assigned as a Plans and Programs Officer at Headquarters Eighth Air Force. In this position, he worked on basing and unit plans, future systems, and budget issues for the Eighth Air Force Commander. From 1984 until 1986, Major Killebrew was the Commander of the 2nd Services Squadron at Barksdale AFB. He is currently attending Air Command and Staff College at Maxwell AFB, Alabama.

Major Killebrew earned a Bachelor of Science in Business Administration and Marketing from Indiana University and a Master of Science in Systems Management from the University of Southern California. His military education includes Squadron Officer School in residence and Air Command and Staff College previously by seminar. Major Killebrew is married. He and his wife, Gayle, have received assignment to Headquarters Strategic Air Command/DOOO after graduation from Air Command and Staff College.

CONTINUED

a role for man in space. The program suffered the same fate as Dyna Soar for many of the same reasons. Its cancellation came amidst Congressional cries of duplication with civilian programs and demands for budget cuts. MOL was canceled in 1969 without finding a useful purpose for putting military man in space. Next came the Space Shuttle program. For the military, the Shuttle was to be the sole means of placing satellites in earth orbit. It still did not define man's role other than placing, retrieving, and repairing satellites in space. The Air Force is currently developing the Aerospace Plane as a follow-on to the Space Shuttle, and is also considering the usefulness of a space station.

IV. Conclusion. The Air Force must establish a clear-cut role for man in space before it can establish a permanent manned presence in space. The Shuttle and NASA's Space Station offer opportunities for the Air Force in finding that role. If the Air Force fails in its effort to find the elusive role, there is a good possibility that future manned Air Force programs, such as the Aerospace Plane, will suffer the same fate as their predecessors. If the Air Force leadership desires a man in space, it must convince Congress that military men stationed in space are vital to national security. Short of that, the United States will continue to rely on automated systems to perform military functions in outer space.

INTRODUCTION

A manned military presence in space, the subject of this paper, has been debated for nearly half a century. Many questions remain unanswered. Is there a valid need for a military man in space? Can a man in space do anything to improve upon automated systems? Can automated systems do the job better and with less risk to human life? These are among the questions addressed here. This paper also examines the Air Force's past and present plans for a manned military space role, and briefly traces the programs developed by the Department of Defense and the Air Force in their attempt to establish a military mission for man in space.

In response to this debate, the Air Force has attempted on numerous occasions to define man's role in the military space program. Lee Brown wrote in The Threshold of Space, 1945-1959 that, "Late in 1958, the Air Force attempted to specify its exact role in space for the sake of long-range planning and development," but with little success. (25:19)

On February 3, 1964, shortly after the Air Force had switched from Dyna Soar (for dynamic soaring) to the Manned Orbiting Laboratory, Secretary of the Air Force Eugene M. Zuckert testified before the House Armed Services Committee:

> In the field of military applications of space our views as to the future remain unchanged. We believe that we must vigorously exploit the most likely avenues of interest, though we are not yet able to be definitive enough to describe man's military space role adequately to project weapon systems. . . . (37:44)

Despite the change in research vehicles, the Air Force continued to grope for a role in space for the military man. This search continued after the cancellation of the orbiting laboratory and the switch to the Space Shuttle. The hunt for a military manned space role continues even as systems such as the Aerospace Plane (X-30) and NASA's National Space Station are planned. The USAF Scientific Advisory Board in June 1983 concluded:

> A review of operational DOD missions in space has identified no military application that requires a manned space station. However, events and technology have changed the military roles and missions in the past and may do so again. . . . Some of these [new missions] are complex and are today not well understood. These potential missions justify DOD participating in the [Manned National Space Station] as a user interested in exploiting technical opportunities. . . . (43:3)

And so, despite years of research and feasibility studies, the search for a manned space role continues. This paper is the story of the Air Force's search for that role from World War II until today.

CHAPTER ONE

EARLY YEARS OF MILITARY INVOLVEMENT IN SPACE

First Steps

For centuries, man has looked longingly at space and wondered at its vastness. It has only been in the last century that he has actually succeeded in reaching out for space and making use of it. Possibly the first person to realize that man could achieve space flight was the Russian, Konstantin Tsiolkovski. In 1883 he began to espouse the theory that rockets would be needed if man was ever to have space travel. In his book Exploration of Space and Reactive Devices, which was first published in 1903, Tsiolkovski proposed the use of liquid fuel and multi-stage rockets. Tsiolkovski claimed that gas escaping into space would drive its containing vessel. He went on to say that the use of multi-stage rockets would make capable the lifting of more weight and, as a result, more fuel than could a single stage rocket. A multi-stage rocket could be lifted into space by burning propellant and then casting off the expended stage while the rocket continued its flight into space. The rocket itself would become lighter as it ascended. (7:21-22)

Tsiolkovski's ideas would be the basis for much of Nazi Germany's work at Peenemunde during World War II. Shortly before the end of the war, on January 24, 1945, German scientists successfully launched an A-9 rocket. The A-9 was a

winged prototype of what was planned as the first intercontinental missile, the A-10. Had it been completed, the missile would have been used to attack the United States from Germany. However, the A-9 was an impressive scientific achievement in its own right. In test launches, the A-9 was propelled to an altitude of nearly 264,000 feet at a speed of 2,700 mph. (26:49) Doctor Walter Dornberger, then a Lieutenant General in the German Army and Commander of Peenemunde, declared: "We have led our generation to the threshold of space--the road to the stars is now open." (7:49)

The Germans were truly on the verge of entering space when the war ended. What was to amaze the Allies at the end of World War II was that the A-10 was not the only space system considered by the Germans. Another system was also considered and rejected fairly early in the war.

Silver Bird and Sanger

Another method of entering space evaluated by the Germans did not depend exclusively on ballistics. The scientist that developed this idea, Eugene Sanger, called his method of space flight "Silbervogel" (Silver Bird). Sanger, who began his research in 1935, continued to pursue it until his death in 1964. The Silver Bird, which Sanger worked on so long and diligently, was to be a manned, recoverable vehicle which could

fly like an airplane in the atmosphere and like a spacecraft when in space.

Kenneth Gatland and Phillip Bono, in their book Frontiers of Space, discussed Sanger's work in Germany during World War II:

> Before World War II, Sanger was called from Vienna and entrusted with the formation of the Research Institute for the Technique of Rocket Flight at Trauen, Germany, where his ideas were considerably extended with the aim of producing an antipodal bomber. The research undertaken. . .was remarkable and far ahead of its time. Although terminated in 1942, its general conclusions were to dominate aerospace technology for a generation. (1:137)

Sanger's intercontinental bomber called for a vehicle launched using a captive booster. The booster Sanger described was unusual but workable.

> [The vehicle would be launched] along a monorail track 1.8 miles long. Near the end of the track, the booster sled would be braked and ultimately brought to rest while the aircraft took off at about Mach 1.5 and climbed at a 30 degree angle. At 5,500 feet altitude, the craft would fire its own rocket engine to achieve a ballistic flight path extending 100 miles into space. The craft would use 'skip' technique, bouncing off the earth's atmosphere to extend its range. (1:138)

The idea was dropped by the German military in 1942 in favor of developing the A-4 (later called V-2), A-9, and A-10, since the technology required to develop these systems would be much less than that required for the Silver Bird system. Despite its rejection during the war, Sanger believed in the

validity of his concept, and argued that one day his system would "ferry, supply, and furnish rescue equipment to manned space stations." (13:196) Shortly before his death in 1964 he asserted:

> When a quarter of a century ago, space flight first became a technical reality, two fundamentally different avenues of development existed. On the one hand, we could develop the ballistic missile-like spacecraft, essentially similar to the proposals of Tsiolkovski, Goddard, Oberth and Esnault Pelterie; whilst on the other hand, lay the further development of aircraft engineering towards space vehicles capable of cosmic flight, the so-called aerodynamic way to space, as advanced by a group of Viennese scientists, including von Hoefft, Valier and Sanger. (13:197)

The arguments Sanger advanced in that lecture would continue to be debated through the early development of space flight in the United States.

X-1, X-2, and Aerobee Rockets

The United States began its fledgling attempts toward space flight in areas that ranged from rocketry to the development of aircraft that tested aerodynamics at high speed and high altitudes. The National Advisory Committee for Aeronautics (NACA) and the Army, Air Force, and Navy each had its own programs and concurrently looked at ballistic rocketry and aerodynamic spaceflight. The services also sought to explore

the physiological and psychological effects on man of flight in the upper atmosphere and beyond.

The aircraft program was initiated in February 1945 when the US Army Air Forces (USAAF) contracted with Bell Aircraft Corporation to produce three X-1, transonic-capable, flight research aircraft. In December 1945 the USAAF contracted with Bell for three follow-on X-2 aircraft. These aircraft would play a significant role for both NACA and the USAAF because they were the first American aircraft that used liquid propellant rocket engines. (26:49-52) The X-1 first flew on 19 January 1946, while the X-2 would not be flown until 27 June 1952. By the time of the X-2 flight, Captain Chuck Yeager had already made his historic flight that attained supersonic velocity on 14 October 1947.

In 1946 other experiments also took place that had an impact on the possibilities of manned space flight. On 17 December 1946 the National Institute of Health, with the help of the USAAF, began space biological research at Holloman Army Air Field in New Mexico. (26:57) By 1952 the United States Air Force began using Aerobee rockets to fire living monkeys and mice into space to determine their reactions to the environment. Kenneth Gatland described these experiments:

> inside pressurized capsules. . .[and] received a supply of recirculated oxygen. Instruments attached to their bodies allowed measurement of blood pressure, heart action, pulse and respiration and. . . was telemetered to the ground. Data received indicated that the monkeys were not seriously

> disturbed by the actual flight. . . . An Aerobee launched. . .in 1952 was partially successful in showing the reactions of mammals under weightlessness. (3:149-150)

These results, analyzed by Doctor J. P. Henry of the Wright Field Aeromedical Laboratory, suggested that "man would have no difficulty in performing all actions necessary to control a vehicle in a weightless state."(3:149-150) Man could fly and survive in space--at least for short periods of time.

X-15 Program

On 14 July 1952 the National Advisory Committee for Aeronautics' Executive Committee began a study on the problems associated with manned flight beyond the earth's atmosphere. The study resulted in a May 1954 decision to build a manned research vehicle which would follow through with research information gained in the X-1, X-2, and Aerobee flight programs. On 9 July 1954 NACA met with Air Force and Navy representatives to "propose the X-15 as an extension of the cooperative rocket research program." This proposal was accepted by the two services and the X-15 program began. (26:75) General Thomas D. White, Chief of Staff of the Air Force, observed:

> Air Force progress toward space has been evolutionary--the natural development and extension of speed, altitude and sustained flight. . . . Actually, the Air Force has been penetrating the fringes of space for several years with manned aircraft. Men like Yeager, Everest, Apt and Kinchloe have been our pioneers. The North American X-15

> rocket research plane, which is now under development as a joint effort on the part of the Air Force, Navy and NASA will be our first aerospace craft. It is expected to travel at speeds of a mile a second and altitudes of more than a hundred miles above the earth. It is only a step away from manned orbital flight. (15:14)

The process of reaching for space was indeed evolutionary. The X-1 exceeded 90,000 feet and 1,600 mph. The X-2 flew to altitudes over 126,000 feet and at speeds of 1,900 mph. The X-15 was designed to fly at altitudes in excess of 300,000 feet and speeds of more than 4,000 mph, its rocket engines producing over 50,000 pounds of thrust.

"The real mission of the X-15," according to a NASA handbook, "is the quest for knowledge." When outside of the aerodynamically effective atmosphere, the pilot controlled his plane using reaction jets. He experienced weightlessness for brief periods of time and had to reenter the earth's atmosphere much like a spacecraft. The X-15 was dropped from a B-52 carrier aircraft, after which the pilot started the rocket engines to attain speed and altitude. After the rocket burned out, the pilot used the vehicle's aerodynamics as an airplane to glide back to a landing. (40:1) "The X-15 program had a simple basis: A series of progressive steps to higher speeds and higher altitudes, each step providing new data or confirming theoretical or wind tunnel data on the characteristics of an airplane performing in a very advanced flight regime." (40:19)

The X-15, which began flight testing on 8 June 1959, produced many benefits in preparation for manned spaceflight.

It helped develop manned space technology prior to the first Project Mercury flight. By the time Alan Shepard flew the first orbital flight on 5 May 1961, NASA knew that there would be no ill biological effects because of the research performed in the X-15 program. Before Shepard made his suborbital flight, the X-15 had already flown to an altitude of 169,600 feet and at speeds of over 3,000 mph. The highest of these flights produced approximately two minutes of weightlessness. (42:iii)

After Shepard's 1961 flight, the X-15 program and Project Mercury became parallel approaches to research of manned space flight. But more importantly from the Air Force's point-of-view, the X-15 helped prove Sanger's Silver Bird theories that a boost-glide type space vehicle would work. As Wendell Stillwell observed:

> Now that men have begun long range planning of the nation's space program, they envision daily shuttle runs to orbital space laboratories and foresee the need for efficient, reusable space ferries. . . . Scientists now talk of two-stage rocket planes and recoverable boosters. Also proponents of the two principle means of orbital and suborbital reentry-ballistic capsule and lifting bodies-are close together, for the force that slows a capsule can be used for maneuvering as the X-15 has proved. (42:6)

The Air Force's interest in the X-15 program and Sanger's Silver Bird suggested a follow-on to the X-15 program. The follow-on became known as the Rocket Bomber (ROBO), later as Dyna Soar (for Dynamic Soaring vehicle), and eventually the X-20. The X-15 program, however, was destined to outlive the

Dyna Soar program. Before the X-15 was retired from research, it had set an altitude record of 354,200 feet and a speed record of 4,520 mph, producing a total flight time for all three X-15s of thirty hours. (11:152) Dyna Soar expected to build on the scientific information collected in the X-15 program and become the first aerodynamic vehicle to enter space.

CHAPTER TWO

X-20, DYNA SOAR SPACECRAFT

Air Force Interest Starts

Sanger's Silver Bird theories were fully investigated by the United States military after World War II ended. Investigations centered around aircraft-shaped boosters in multi-stage configurations. Dr. Walter Dornberger, who worked after the war as a consultant for Bell Airplane Company, the producers of the X-1 and X-2, advocated Sanger's ideas. (1:139) In 1954 the US Air Force became interested in Dornberger's suggestion that Sanger's Silver Bird be developed in the United States. Studies of the concept were made before the program was put into development.

In 1948 Rand produced a favorable analysis of Sanger's 'boost-glide' vehicle. In 1952 Dr. Dornberger, through Bell, proposed that "a manned hypersonic boost-glide bomber/ reconnaissance system" be developed by the Air Force. (24:45) This concept combined Sanger's ideas with the results of the earlier Rand study. The Air Force subsequently awarded Bell contracts to develop the boost-glide vehicle idea. Bell proposed to build two versions of the boost-glide vehicle, making one a Bomber Missile (initially nicknamed BOMI and later called Rocket Bomber or ROBO), and the other a reconnaissance spacecraft (nicknamed Brass Bell). (24:45-59) Automation had

not yet reached a stage where ICBM's could be considered accurate, and a manned orbital bomber was thought to be needed to improve the accuracy of intercontinental bombing. (2:81) In April 1957 Headquarters USAF consolidated these programs into a single project called Dyna Soar, for Dynamic Soaring Vehicle. This project was to be jointly worked by NACA, Rand, and the Air Research Development Center (ARDC), and was put under three development categories: Dyna Soar I, originally the Hywards program, which was strictly research of space flight using a boost-glide vehicle; Dyna Soar II, originally the Brass Bell reconnaissance program; and Dyna Soar III, originally the ROBO or Rocket Bomber program. The proposed development schedule in the summer of 1957 called for:

	D.S.I	D.S.II	D.S.III
1st Flight	1963	1966	1970
IOC*	NA	1969	1974
Range	NA	5,000 mi	circumnavigate the globe

*initial operational capability
(24:46)

Through the Dyna Soar program, the Air Force hoped to determine the military usefulness of manned space flight and perfect an offensive weapon system.

One month after this schedule was set, on October 4, 1957, the Soviet Union successfully launched the first vehicle to achieve Earth orbit--Sputnik I. Air Force leaders believed that efforts needed to be intensified so that the United States would have a military space presence as soon as possible given the

Soviet achievement. As a result, the Air Staff quickly changed Dyna Soar's schedule:

	D.S.I	D.S.II	D.S.III
1st Flight	1962	1964	1965
IOC*	NA	1967	1968

*initial operational capability
(24:46)

The Eisenhower Administration, however, did not necessarily concur with this plan.

Administration Skeptical of Need

The Republican Eisenhower Administration, even after the Sputnik success, remained skeptical of the need for an expanded and accelerated space program. Administration officials believed the benefits derived from scientific space exploration were justified, but that the military uses of a manned space program were few, if any at all. (14:44) Defense Secretary Charles F. Wilson labelled the Soviet feat "a neat scientific trick." (14:1) But Democrat Adlai Stevenson declared, ". . .not just our pride, but our security is at stake. . .", and most Americans agreed with him. (14:1) On 3 November 1957 Sputnik II achieved orbit carrying a dog named Laika, increasing the anti-administration rhetoric. The U.S. public wanted the U.S. space program to progress at a faster pace, and the news media agreed. (6:145-147) One month later, Maxime A. Faget of the NACA Langley Laboratory proposed the ballistic-shaped space vehicle

which was to become the basis of the Mercury program. At about the same time, Alfred J. Eggers, Jr., of NACA's Ames Laboratory, and Eugene S. Love and John V. Becker, both of Langley, proposed that the better method of space flight would be to develop a boost-glide configuration such as Dyna Soar. (26:93)

On 13 January 1958 President Dwight D. Eisenhower proposed in a letter to Soviet Premier Nikolai Bulganin that the Soviet Union and the United States agree that outer space be used only for peaceful purposes Peaceful uses, in Eisenhower's view, also embraced military support missions in space, but not offensive weapon systems. Although not immediately accepted by the Soviets, future American presidents adopted this interpretation of the peaceful uses of outer space, and it would remain in effect until modified by President Ronald Reagan in 1982.

While Eisenhower proposed the peaceful uses of space, he established the Advanced Research Projects Agency (ARPA) to coordinate all military services' outer space programs. (26:94) The Air Force space program, prior to the organization of ARPA, consisted of both military support (Dyna Soar I) and offensive (Dyna Soar II and III) manned space programs. Air Force plans in January 1958 called on Dyna Soar for: 1) manned capsule and conceptual testing, 2) boost-glide tactical weapons delivery, 3) boost-glide interceptor, 4) satellite interceptor, 5) global reconnaissance, and 6) a global bomber. (24:132) Although President Eisenhower's letter to the Soviet Premier threatened

the prospects of many of these missions, another event threatened the remainder of the Dyna Soar space program. This event was the establishment of a civilian space agency in the summer of 1958.

On 26 July 1958 President Eisenhower signed the National Aeronautics and Space Act of 1958 creating the National Aeronautics and Space Administration (NASA). In a prepared statement, Eisenhower asserted, "The present National Advisory Committee for Aeronautics (NACA). . .will provide the nucleus for NASA. The National Advisory Committee for Aeronautics has an established record of research performance and cooperation with the armed services." (26:100)

The establishment of NASA resulted in the transfer of all scientific manned programs along with related facilities from the Air Force, Army, and ARPA to NASA's control. Before the formation of NASA, the Jet Propulsion Laboratory at the California Institute of Technology, the Naval Research Laboratory, and ARPA worked with the DOD and the services. After the National Aeronautics and Space Act was signed, many of these agencies were assigned to NASA. (14:50) ARPA attempted to keep military losses to a minimum. When NASA was established, the prevailing military thought was that the United States must not permit a foreign power to control space. An ARPA spokesman stated, "A strong military research and development program that will lead to manned and unmanned space orbiting weapon systems and space flight vehicles to permit military operations in space

can be the key to future national survival." (24:146-147) ARPA, nevertheless, lost its battle with the newly formed space agency. All scientific satellite and most manned space programs passed to NASA's control in 1959. The USAF did manage, however, to retain one manned space program which it felt vital to the national security--the Dyna Soar program. An Air Force officer involved in the program opined:

> The Air Force has been successful in retaining Dyna Soar by asserting that it has less than an orbital capability. This procedure has thus far succeeded in thwarting ARPA's overtures to take over the program. The Director of ARPA has stated that the Dyna Soar program is the best approach toward the goal of manned space vehicles having a military capability. It is anticipated that ARPA will develop some type of man-in-space program patterned after the Dyna Soar program. The Air Force continued for some time to emphasize the suborbital. . .characteristics of Dyna Soar while going forward with its development as rapidly as weak funding and strong opposition. . .permitted. (24:168)

Dyna Soar and a Manned Space Mission

The Air Force wanted the Dyna Soar program and had been directing its efforts toward orbital flight all along, despite occasional assurances to the contrary to ARPA and NASA. From the outset of the Air Force's research on the use of space, Rand, ARDC, and the Ballistic Missile Division at Kirtland AFB, NM, had discussed plans for manned, recoverable Earth orbiters, a space station, and an expendable lunar lander. (25:7) These farsighted recommendations were made two to three years prior to

Sputnik I. Dyna Soar, to the thinking of these agencies, could perform the first of these three missions.

In the late 1950s Dyna Soar's mission would: 1) demonstrate piloted maneuvering reentry and man's ability to glide to a conventional site and land, 2) gather research data on reentry, and 3) explore the full potential of the pilot in space flight. (12:81) Purpose statements no longer discussed potential offensive uses of Dyna Soar. USAF leaders were convinced of the need for manned spacecraft, even though they could not define precisely the reasons why. They claimed manned missions of value because man could react to his environment, make repairs, and work to overcome unanticipated events. (14:67) Based on the perceived if ill-defined need for manned space flight, the Air Force in December 1957 requested proposals from industry for a hypersonic maneuverable reentry vehicle. (12:81) On 16 June 1958 Phase I contracts for development of Dyna Soar were awarded to the Martin Company and the Boeing Company. (26:99) A year and a half later, on 10 November 1959, contracts were let with the two companies for full scale development. (26:114) The Dyna Soar program was under way.

Dyna Soar was initially designed as a delta winged spacecraft to be launched on a booster rocket. The booster was to use off-the-shelf technology. This resulted in a January 1958 decision to mate the Dyna Soar with a cluster of Minuteman solid propellant rockets then under development for the USAF ICBM force. The dynamics of separating these clustered rockets

one-at-a-time as they were expended, however, proved too complex and costly. The program was changed in July 1959 when Boeing proposed the Atlas Centaur rocket as a booster. The Air Force, however, decided in April 1960 to develop a new liquid propellant rocket, the Titan I. This went along with Air Force statements that the Dyna Soar was only to be used for suborbital flights, which was all the Titan I could achieve. It was not long, though, before the Air Force changed direction and made the Titan II the launch vehicle, claiming the change necessary because the Dyna Soar vehicle was going to be heavier than expected and would need more boost for the heavier payload. By January 1962 plans had shifted to a new booster, the Titan III, giving Dyna Soar orbital capability. The Titan III was modified into the Titan IIIC in January 1963 when it was decided that time in space needed to be increased to three orbits with some capability for space maneuverability. (12:82)

The reentry vehicle's design went through many changes as well. The 1958 proposal was little more than an engineer's sketch. When the drawing was considered technically, it was found that the vehicle could not withstand the heat generated during reentry and would encounter severe roll and yaw problems when operating inside the atmosphere. A new design was presented in 1960. This design incorporated a small turbojet to be started on reentry and used in the final stages of landing. Again, it did not take long to discover that a turbojet could not be started at the extreme altitudes and speeds associated

with reentry, and that by the time the altitude was low enough to allow the engine to be started, it would not have sufficient spool time to help in the landing. The idea was quickly dropped. (12:82)

In 1962 the final design for the Dyna Soar was introduced and confirmed in formal testing. The rear of this newly designed vehicle attached to the Titan IIIC through a transtage vehicle, which would remain attached to Dyna Soar for limited maneuvering in space. The transtage would give Dyna Soar the degree of flexibility the Air Force thought needed to maneuver to investigate events as they occurred while the spacecraft was in orbit. (12:82) This constant shifting and redesigning significantly added to costs, and eventually contributed to the decision to cancel Dyna Soar altogether.

Dyna Soar Political Problems

On April 12, 1961, the Soviet Union orbited Major Yuri Gagarin around the earth in a Vostock spacecraft. Prior to this event, the Air Force and DOD put great stock in the new President, John F. Kennedy, Jr. President Kennedy's decision to accelerate both military and civilian space programs resulted in Dyna Soar sharing in an additional $144 million to speed development. This support soon ended with Gagarin's flight. President Kennedy announced a redirection of the national space

effort in his 25 May 1961 State of the Union Address. In it Kennedy said, "Now is the time to take longer strides--time for a great new American enterprise--time for this Nation to take a clearly leading role in space achievement which in many ways may hold the key to our future on Earth." He then set as goals: 1) landing a man on the Moon and returning him safely to Earth by the end of the decade, 2) the early development of a nuclear powered rocket, 3) orbiting of a satellite communications network, and 4) orbiting a satellite weather network. (34:22) This ultimately meant less money for the USAF manned space effort.

Dyna Soar pilot selection started in July 1961, with both NASA and USAF pilots considered for the suborbital program. (34:33) Not long afterward, however, the development times were reduced when DOD authorized a direct transition from the B-52 drop flights to unmanned and manned orbital flights. This eliminated the step-one suborbital program in an attempt to keep costs down and get Dyna Soar into space sooner. (34:76)

In July 1962 22 pilots were selected and Dyna Soar was renamed the X-20 program. Congressmen, however, increasingly accused NASA and the USAF of duplicating manned space flight efforts in the Mercury and X-20 programs. In September Secretary of the Air Force Eugene M. Zuckert responded:

> In addition to our contribution to the success of the NASA program, the Air Force is required by its own mission to put its energies into a different kind of space effort. . . . The United States is dedicated. . .to the peaceful exploitation of the space medium. . . . The dual orbital experiment of the Soviets, when coupled with their previous

> claims, seems to indicate that the need for protection against possible threats to our security will be in the near orbital stage of space, rather than farther out. (35:197)

It was the near orbital stage of space where the X-20 was designed to operate and protect our space interests. But troubles for the X-20, despite Secretary Zuckert's assurances, were mounting quickly. Offering generalities about "possible threats" to national security proved insufficient. What the Congress and the Air Force needed were concrete specifics about the military uses and value of Dyna Soar.

Dyna Soar Cancellation

After visiting Boeing in Seattle and the NASA Manned Spacecraft Center in Houston, in early 1963, Secretary of Defense Robert S. McNamara declared:

> In the last six months the Department of Defense has completed with NASA an agreement on joint planning for the NASA Gemini Program. We want to see how Gemini and the X-20 can be fitted together to make the best program for both military and civilian purposes. (36:90)

Later, at a House Armed Services Committee hearing, McNamara testified:

> A substantial amount of funding (for FY 64) is requested for Dyna Soar. . . . I personally believe that rather substantial changes lie ahead of us in

> this Dyna Soar. I say this, in part, because of the Gemini development. Gemini is a satellite. . . on which has been spent to date $300 million. . . toward a total program cost of $800 million. Gemini is a competitive development with Dyna Soar in the sense that each of them are (sic) designed to provide low earth orbit manned flight. . . . (36:115)

Obviously, this statement did little to protect the X-20 program. In the same House testimony, McNamara said:

> We don't have any clear military requirement, or any known military requirement [for Dyna Soar], per se. But, I think we do have a requirement for environmental testing and experimentation in near-earth orbit. . . . I guess that we will find that Gemini has a greater military potential for us. . . than does Dyna Soar. . .and [Dyna Soar will] cost to complete. . .something on the order of $800 million to a billion dollars. The question is, do we meet a rather ill-defined military requirement. . .better by modifying Gemini in some joint project with NASA. . . . (36:115)

In June 1963 the House of Representatives passed a DOD authorization bill for FY 1964, one that included $125 million for the X-20 program along with the House's strong endorsement. (37:256) Despite this, Secretary McNamara canceled the Dyna Soar program on 10 December 1963. Part of the money authorized for the X-20 program was to be diverted to a new program--the Manned Orbiting Laboratory (MOL). At the time of its cancellation, Boeing was producing a full scale Dyna Soar test vehicle. The vehicle would never be finished. Growing costs, growing complexity, and the lack of a clear military objective sealed the X-20's fate. Another reason: the X-20 was over twice

the weight of a ballistic capsule with the same payload capability. The Air Force shifted its manned military space program effort to the Manned Orbiting Laboratory (MOL), which used NASA's Gemini ballistic capsules. (1:142)

CHAPTER THREE

MANNED ORBITING LABORATORY (MOL)

Blue Gemini

The Blue Gemini concept was an Air Force manned space flight program to develop rendezvous, docking, and transfer of personnel and equipment for military purposes using Gemini-type spacecraft. The concept surfaced during Congressional hearings on the FY 1963 DOD budget as part of an Air Force plan to develop space technology. Back in 1962, Air Force Space Systems Division explored ways to use Gemini for an Air Force controlled man-in-space program called Manned Orbital Development System (MODS). MODS consisted of a military space station using Gemini as a ferry to get to and from the station. The Blue Gemini proposal would allow Air Force pilots to fly on six Gemini missions so that the Air Force would have a bank of experienced astronauts to fly the MODS missions. (28:120)

According to Hacker and Grimwood's history of the Gemini program, Blue Gemini brought a mixed response in the Air Force and NASA. Some in the Air Force, including Chief of Staff Curtis E. LeMay, correctly perceived that the program would jeopardize the Dyna Soar development program. Blue Gemini, others believed, could be ready in the very near term since it would use technology and hardware from the civilian program, which would be ready much earlier than would the X-20. NASA

supported the idea of Blue Gemini because it would bring an infusion of defense funds. But Defense Secretary McNamara surprised both the Air Force and NASA by proposing the X-20 program and Gemini be merged into a single program under DOD management. NASA then began to balk, and NASA's W. Fred Boone, the Deputy Associate Administrator for Defense Affairs, observed:

> It is in the national interest that the management of Project Gemini remain with NASA's Manned Spacecraft Center. A change in program management would seriously delay and substantially increase the cost of the manned lunar landing program. Any delay would reduce the chances that the United States will make a manned lunar landing before the Russians do. (28:120)

When NASA fought McNamara's takeover proposal, he came back with a new proposal for a merger and joint management of Gemini by the Air Force and NASA. Again, Air Force leadership feared they would lose the X-20 program. NASA, for its part, used the same reasons to fight joint management. Instead, NASA suggested a steering board be formed. The Gemini Program Planning Board was the result, with no real power over the program. The real power remained in NASA's hands where NASA wanted it. According to Boone, the board allowed the Air Force to help "in the development, pilot training, pre-flight check-out, launch operations, and flight operations of the Gemini Program to assist NASA and to meet DOD objectives." In other words, there would be no change in the current relationship between the two organizations. (28:121)

MOL Program Beginnings

The MODS/Blue Gemini proposal was not totally wasted; it did lay the groundwork for what became the Air Force's own Gemini program--the Gemini B/Manned Orbiting Laboratory. (28:171) McNamara formally announced the new program to Congress on 10 December 1963. In doing so, he canceled the X-20 program and declared that the Manned Orbiting Laboratory would be the primary project to find a military use of manned space stations, and, for that matter, a military need for manned space flight. When the new program was announced, Air Force Secretary Zuckert stated, "We welcome the assignment of the Manned Orbiting Laboratory Project, and we will now concentrate our resources and best management effort on this job. . . . This will assure effective Air Force participation in the manned space program." (36:474)

In 1964 a pre-program study by the Defense Analysis Institute observed that "MOL will exist primarily for the purpose of providing test facilities to evaluate man's ability to make significant contributions to military functions in an orbital environment." The study placed the emphasis of the program on testing the ability of human beings to 1) maintain mental health in extended orbits of up to thirty days, 2) maintain physical health in extended orbit, 3) use his manual dexterity in a space environment, and 4) to see if man could improve upon the results achieved with automated and semi-

automated equipment. (29:1-3) But only the fourth of these objectives vaguely referred to what military men might accomplish in space.

MOL would also be a test, as Dyna Soar was to have been, of the usefulness of man in a military space role. It was designed to see if man could enhance reconnaissance, bombing, and command and control roles in space. One of the tests of his capabilities would be a reconnaissance test. In this concept, astronauts would sort through reconnaissance data collected automatically, focus sensors on specific areas of interest, and put the selected materials into canisters which would be jettisoned from the spacecraft, reenter the earth's atmosphere, and be recovered by the Air Force. Astronauts, in this early idea, would shuttle back and forth between Earth and the MOL via Gemini spacecraft. (14:68)

MOL Political Problems

Even though McNamara announced the program in December 1963, and much of the concept work was completed in 1964, the program was not formally blessed by President Johnson until August 1965, when he approved the building of five MOLs. Part of the reason for the long delay between McNamara's announcement and the President's approval was the on-going argument over whether the Air Force and NASA should both have a manned space

role. Dr. Harold Brown, DOD's Director of Research and Engineering, summed up the military's side of the argument when he testified before the House Armed Services Committee on Research and Development on 14 February 1964:

> But. . .this could grow into a space station if and after. . .we conclude. . .that a man can have a substantial military purpose [in space]. [DOD should] move more aggressively into the manned space flight arena in order to explore more fully man's utility for the performance of military space missions. . . . (37:65)

Powerful politicians such as Senator Clinton P. Anderson, Chairman of the Senate Committee on Aeronautical and Space Sciences, in a letter to President Johnson on 8 November 1964, went even further and urged the merger of MOL and Apollo X (later Skylab) programs to make a jointly operated space station and save the taxpayer $1 billion. (37:382) The Air Force in this instance found a strong ally in NASA, which wished to remain completely separate from military spacefaring. The Deputy Associate Administrator for Space Sciences and Applications, Edgar M. Cortright, stated that there was a fundamental difference in what NASA and DOD was trying to achieve with Apollo and MOL. "NASA's role is to explore and exploit space for peaceful purposes. The DOD's role is to stay prepared to defend the United States and its allies. . . ." The two missions, he argued, did not go together. (38:183)

MOL, however, had its share of congressional supporters. These supporters helped to resolve the controversy in favor of

MOL development. On 3 June 1965 the Military Operations Subcommittee of the House Committee on Government Operations stated in a report that the DOD should commence full-scale development of the Manned Orbital Laboratory without further delay. Others, such as Representative John W. Wyder of the House Science and Astronautics Committee, used even stronger language. Charging a Soviet threat in space in a letter to the New York Times, Wyder said:

> It is time now to put the manned military control of space on a crash basis equal to the Apollo program. The first MOL flight is scheduled from two and one half to three years from now. This should be speeded up at least a year and the necessary sacrifices made to achieve it. . . . To achieve our goals effectively, the manned earth orbiting program should be placed under military control. . . . The decision we must make is not whether there will be military control of space but whether that control will be Russian or our own. . . .(38:290-291)

On 25 August 1965 President Johnson approved the MOL development program, estimating its cost at $1.5 billion. At a news conference, the President said:

> This program will bring us new knowledge about what man is able to do in space. It will enable us to relate that ability to the defense of America. . . . Unmanned flights to test launching, recovery and other basic parts of the system will begin late next year or early 1967. The initial unmanned launch of a fully equipped laboratory is scheduled for 1968. This will be followed later that year by the first of five flights with two-man crews. . . . [The US will] live up to our agreement not to orbit weapons of mass destruction. . . . (38:396)

MOL System and Mission

The $1.5 billion approved by the President for the MOL project would be used to test and develop the booster and to test a modified version of the Gemini capsule as well as developing the laboratory itself. McDonnell Aircraft Corporation was to modify the Gemini capsule, ensuring it would connect with the laboratory produced by Douglas Aircraft Company. Finally, the capsule and MOL would be attached to the top of a Martin Marietta Company produced Titan IIIC. The Gemini capsule would be the same as that used by NASA except that it would have a hatch cut into the heat shield allowing the crewmen access from the capsule into the laboratory. The laboratory itself was to be a cylinder, 51 feet long and 10 feet in diameter, providing living and working facilities for a two man crew. Only 14 feet of the laboratory would be pressurized with the remaining unpressurized 37 feet used for vehicle systems and storables. MOL missions were planned to last thirty days. (16:164)

The launch vehicle was the Titan IIIC booster. Scheduled for operational use in 1965, the Titan IIIC could launch the 1.8 million pound payload using 2.5 million pounds of thrust produced by a combination of liquid and solid propellant motors. By 1968, however, this had been changed to the Titan IIIM which produced 3.2 million pounds of thrust. The additional thrust was needed to assur that polar orbits could be attained,

thereby making the MOL more useful to the military. But, the change further added to the cost of MOL. (16:30-35)

The experiments that the military wanted in a polar orbit were to be designed by industry but conform to desires of the Air Force and Navy. Frank Burnham stated in a 1968 Aviation Week article that 25 experimental areas, of which 15 were primary, were designed for the MOL in accordance with Navy and Air Force guidance. The experiments included: tracking of ground targets using an image velocity sensor subsystem; electromagnetic signal detection; in-space maintenance; tracking of space targets; acquisition of targets of opportunity (both land and sea); extra vehicular activities (EVA) using a remote maneuvering unit to inspect the MOL and other spacecraft; autonomous navigation; post-attack bomb damage assessment; multi-band spectral experiments; general performance of men in military assignments; biological and psychological experiments; ocean surveillance for the Navy; assembly, erection, and alignment of large structures in space; large optics in Earth orbit; material degradation; multi-band spectral analysis of planets; recovery of space objects; air-glow photography; electron density; air-glow analysis; plasma experimentation; communications propagation; ultra violet experiments and passive propellant settling systems. (16:33-35) The Wall Street Journal on 26 August 1965, consolidated all of these missions into three general categories: 1) reconnaissance of the USSR and China, 2) inspection of non-US satellites, and 3) surveillance of the

oceans. These, the newspaper claimed, were the three primary roles of the MOL program. (38:400) These roles did not add measurably to US satellite capabilities. Instead they were primarily tests to see if man could improve on the performance of automatic satellites.

The Washington Post, in an article on MOL in September 1965, said of its mission:

> The primary mission of MOL. . .is without a doubt to have man supplement the machine as a shutterbug spy. . . . Hence man will advance the sensationally successful camera work of the unmanned SAMOS series of photo reconnaissance satellites. . . . Human judgment is the critical new factor. . . . [Men] can use their judgment on what to photograph. . . . They can be selective on when and where to aim. . .new and experimental photographic equipment. [They can also] maintain and repair [this new equipment]. Indeed, it is not inconceivable that. . .manned synchronous [orbit] satellites, able to hover over Russia and the United States [would be] ready to flash instant word of missile firings, rocket tests, nuclear explosions, mass troop movements or other important military activities. (38:416)

J. S. Butz speculated in a 1968 Air Force and Space Digest article that MOLs could be used to manage a fleet of unmanned reconnaissance satellites. The MOLs would be used to "filter and discard large quantities of unnecessary data," reducing the time and volume of transmissions to the ground link. This, added to the repair capability that men would perform on the unmanned satellites when breakdowns occurred, would make the entire system cheap and efficient. (17:255) But before any of these missions could begin, the Air Force had to get the first MOL into orbit. That did not prove to be an easy task.

MOL Cancellation

As early as December 1965, six months after President Johnson formally approved the program, MOL encountered money problems and came under fire from various sources. On December 29 the New World Telegram reported that the mounting costs of the Vietnam War would slow MOL development. (38:567) The year 1966 brought cutbacks in funds for the MOL project. DOD received only $150 million in the FY 67 budget due to tight funding and priorities in other areas. Dr. Robert C. Seamans, Jr., NASA's Deputy Administrator, observed that the "extremely stringent budget" resulted from costs of the Vietnam War and the Great Society social programs. According to Defense Secretary McNamara, the $150 million allocated in FY 1966 and the $150 million in the FY 1967 budget provided for "design, definition, system integration, development of specifications and determination of firm cost proposals." (30:87) But there was not enough money to pay for any operational equipment, although there was enough to allow an important test. This test was the launch of a Titan IIIC with an unmanned modified Gemini capsule attached. The test took place in November 1966 and confirmed that the hatch cut in the heat shield did not degrade its protective capabilities from the intense heat of reentry. (30:338)

President Johnson's FY 1968 budget request, submitted in January 1967, asked Congress to increase MOL funding to $430

million. By that time, MOL was already over budget and two years behind schedule, with a first launch now scheduled for 1970 instead of 1968. The total cost of the MOL program had risen from the $1.5 billion initially announced by the President to approximately $2.2 billion by most current estimates. (31:140) The budget request was again increased in the FY 1969 budget submission to Congress, this time to $600 million. Secretary of Defense McNamara defended the increase in MOL funding before Congress saying, "FY 69 is expected to be a peak year of activity in the MOL program." The $600 million would not launch the first MOL, but it would complete much of the testing of the system.

The program's real troubles began when Congress demanded, in FY 1969 budget hearings, that the DOD cut $900 million from its budget, or Congress would do it. On 19 May 1968 Senator Edward Kennedy described the mood of Congress, and much of the nation, when he urged the slowing of the entire US space program after the completion of the lunar landing and exploration. He said, ". . .a substantial portion of the space budget [should] be diverted. . .[to] pressing problems [at home]. . . . We need a dedication not only to the national security. . .[but] to social justice [as well]. . . .(11:222) A Harris Poll, taken on 14 July 1968, confirmed Senator Kennedy's view. The poll showed that most Americans did not think the space program worth $4 billion a year. Those polled agreed that NASA should complete

the lunar exploration program, but that when it was over, space programs should be slowed or stopped. (11:223)

In 1969 President Nixon asked Congress for $576 million in the FY 1970 budget for MOL. By this time both the NASA orbiting workshop and MOL were scheduled for launch in 1971. As a result, numerous Congressmen claimed duplication between the NASA and DOD space projects. The issue of wasteful duplication, mounting costs, and a three year delay of MOL ultimately concluded in the announcement of MOL's cancellation on 10 June 1969. Deputy Secretary of Defense David Packard announced the cancellation citing the "continuing urgency of reducing Federal Defense spending" and rapid "advances in automated techniques for unmanned satellites" that negated the primary role of MOL. (32:176)

The outcry from proponents of the system was immediate. Lieutenant General Ira C. Eaker (USAF, Ret) wrote a letter to the Detroit News:

> access the capability of intercepting, inspecting and, if need be, destroying hostile weapons in space. Cancellation. . .concedes to the Russians control of space. After 1972, the Russians will have the capability of overhauling and destroying our reconnaissance satellites, and they will also be capable of placing weapons in space which we can neither intercept, identify nor disarm. (32:191)

Despite concerns such as Eaker's, the program could not be saved, and the threat did not materialized.

The estimated $3 billion cost if the program were continued (double President Johnson's announced cost in 1965) at a time when funds were needed for the Vietnam War and social programs, resulted in the program's cancellation. The military did manage to accomplish a few of the experiments planned for MOL on NASA's Gemini and Apollo flights. But the usefulness of military man-in-space remained untested. Dr. Edward C. Welsh, formerly NASA's Executive Secretary, observed:

> [MOL cancellation] should at most be a postponement. Contrary to assertions made by people who should know better, the MOL was not planned as a weapon system and would not have been a threat to any other nation. [MOL observations would be] as peaceful as those obtained on the NASA Gemini and Apollo flights. Men on board the spacecraft can be justified by contributions men make in matters of observations, maintenance and communication with Earth. To try to combine the Air Force and NASA manned programs would waste much of the investments already made, would delay both programs, would increase the total cost over the long run, and would violate the sound administrative principle of having the experts do what they have been trained to do. Failure to get a maximum return from the national security system would seem to be woefully shortsighted and wasteful. (32:278)

The combined program which Welsh referred to was the Apollo Applications Program, also known as the Manned Orbiting Research Laboratory (MORL). The MORL program, much more ambitious than was MOL, called for a twelve-man orbiting space station in a low inclination orbit. The MORL would have been strictly scientific in nature while the MOL program was in existence. When the MOL program was canceled, many of the items purchased for it were transferred to the MORL program along with some of the

experiments the military wanted to carry out on a space station. Shortly after MOL cancellation, however, the MORL program was also canceled for many of the same reasons as MOL, i.e., rising costs and declining public and Congressional support.

Major Robert McDonald (USAF), in an Air Command and Staff Research project, believed that MOL and Dyna Soar both failed for essentially the same reasons: 1) unmanned automatic vehicles posed less risk to humans while successfully performing the same missions, 2) NASA was pursuing a comparable, competitive mission at the same time the USAF and DOD were pursuing MOL and Dyna Soar, 3) neither the USAF nor DOD could disprove that automated instruments couldn't better perform most missions the military wanted accomplished, 4) robotics and self-repairing computers were advancing rapidly, eliminating the need for a manned system, and 5) high speed computers and video down-links had made man-in-space unnecessary. (48:16) Still without a man-in-space, DOD officials began realizing that there was limited use for manned military spacecraft.

The extensive research already completed did result in a new program born of the MOL and MORL programs. Throughout the life of the two programs and even before they came into existence, scientists and the military had discussed a better way to ferry people and supplies into space. They wanted to reduce the costs of space flight by eliminating expendable boosters in favor of reuseable ones. Even though MOL and MORL space station programs were canceled, both DOD and NASA

understood the need for a means to work in space in a vehicle that would return to a normal landing on earth. Research conducted on Dyna Soar and MOL/MORL would be used to develop this new system--the Space Transportation System, or, as it is commonly known, the Space Shuttle.

CHAPTER FOUR

SPACE TRANSPORTATION SYSTEM (STS)

Search for a Space Ferry

The concept of a spacecraft capable of ferrying equipment, people, and supplies to and from space was hardly new. Sanger's Silver Bird, discussed in Chapter One, could have performed as a space ferry. The Dyna Soar (X-20) was also thought of as a possible space ferry candidate. Scientists knew, however, that the Dyna Soar was an experimental craft, too small to actually ferry much of anything into space. But Dyna Soar did present scientists with the opportunity to perform research to develop the technology which would one day result in a space ferry system.

Even when the Dyna Soar program was canceled and replaced by the Manned Orbiting Laboratory (MOL), the concept behind the Dyna Soar continued in the form of developing a vehicle capable of resupplying MOL. In testimony before the House Armed Services Committee in February, 1964, Air Force Chief of Staff General Curtis E. LeMay, said:

> maneuverable aerospacecraft capable of controlled reentry and precision recovery, ferrying missions to and from a space laboratory, transfer of men and equipment in space and a wide range of other roles. . . . (37:44-45)

Lifting Body Research

Research toward the aerospace ferry that General LeMay talked about began with the establishment of the Spacecraft Technology and Advanced Reentry Test (START) program in September 1964. START would study the field of reentry through use of the SV-5, M2, and HL-10 lifting body vehicles. The SV-5, which was being built by Martin Marietta Corporation, was intended to test reentry principles and aerodynamics of a reusable, maneuverable spacecraft.(37:308) This program beginning in 1965 tested various shapes, landing capabilities, and the atmospheric maneuverability of a hypersonic reentry vehicle. None of the vehicles were used to actually reenter the atmosphere while manned. One, the SV-5D, was launched unmanned on an Atlas booster rocket to test its reentry characteristics. All three test launches of SV-5D models were deemed successful, although two of the vehicles were not recovered. The tests were called successful because the vehicles were maneuvered after reentry and valuable data was telemetered to earth during the flights. However, only the third craft was recovered. The first craft's parachute malfunctioned and it crashed; the second vehicle was lost when flotation devices failed and it sank in the Pacific Ocean.(31:62-63)

The SV-5P, HL-10, and M2-F2 had only slight structural differences. The SV-5P (later to be renamed the X-24A) was a 5,000 pound, 24 foot long wingless vehicle. The shape of the

vehicle was an airfoil with vertical fins, which gave the vehicle aerodynamic lift. The HL-10 and M2-F2 were almost exactly the same as the SV-5P except that they were somewhat smaller, weighing 4,500 pounds. Both the HL-10 and M2-F2 were wingless, delta-shaped vehicles.

All three START vehicles went through the same flight regimen. Carried aloft by a B-52 to between 45,000 and 50,000 feet, they were released to glide back to earth. This checked their maneuverability and stability. In later testing the vehicles' Thiokol rocket engines were ignited, developing 8,000 pounds of thrust and allowing flight up to 80,000 feet at supersonic speeds thereby simulating reentry conditions. (31:383) These tests were needed because NASA and the Air Force wanted to develop possibilities for future lifting body (or ferry) type vehicles which would be capable of landing on conventional runways. J. V. Teistrup in a Washington Post article suggested ". . .crews might use the [future] vehicles to inspect foreign spacecraft, repair U.S. satellites, make reconnaissance flights, fly in search and rescue operations or take replacement crews and supplies up to manned space stations." (30:14)

START studies built upon much of the work accomplished in the Dyna Soar program. Even the shape of the vehicles was reminiscent of the shape planned of Dyna Soar. START lifting body studies terminated on 20 August 1975. However, they added much useful data on a maneuverable reentry vehicle useful in the later development of the Space Shuttle.

Space Shuttle Conceptual Studies

NASA contracted with the Boeing Company in January 1969 to begin studies of a "space logistics system." The machine could be either reusable or expendable as long as it could supply a space station in 100 to 300 mile earth orbit, lift-off with 5,000 to 50,000 pounds of payload and carry twelve passengers. (32:26) Later that same year, contracts for similar studies were extended to Lockheed, General Dynamics, North American Rockwell, and McDonnell Douglas. (32:47) Whatever system these contractors devised, NASA wanted it operational sometime during 1974-1976.

Air Force Secretary Robert C. Seamans, Jr. expressed the DOD's interest shortly after the cancellation of the MOL project in June 1969. He believed that the shuttle could be jointly developed, saying that there must be savings in space flight operations and this might be accomplished using reusable vehicles. He also suggested that the DOD and NASA research and develop the system together. (32:345) The Space Task Group, chartered by President Nixon and chaired by Vice President Agnew, recommended in 1969 that a Space Transportation System (STS) be developed. Its purpose would be to provide the United States with an efficient way to enter space with flexibility and at less expense than current technology allowed. (44:1)

This system as envisioned by Maxime A. Faget, Manned Spacecraft Director of Engineering Development for NASA, was to

be a 225 foot high vehicle weighing 2.5 million pounds at launch. It would be capable of lifting 25,000 pounds of cargo, including passengers, and would be attached to the booster stage's upper half. Both the booster and orbiter would have wings. The booster would detach from the orbiter close to space and be flown by a two man crew to a landing at an airfield. Once separated from the booster, the orbiter crew would ignite the orbiter's rockets to attain altitudes of 300 miles. During reentry into the earth's atmosphere, the orbiter would be piloted in a controlled glide to a conventional 10,000 foot runway. (32:345)

DOD officials were convinced that a shuttle system, comparable to what Faget described, would answer their manned space needs. In March 1971 Colonel John G. Albert, Director of USAF Space Operations, announced that the DOD was "putting its faith in the shuttle and as a result, we are not developing any other space rocket beyond the Titan III. We intend to use the shuttle for all military space operations." (33:75) This decision in 1971 would have dire consequences in 1986 when the Space Shuttle Challenger exploded. Consequently, the Air Force would be left with a limited number of assets with which to launch satellites. But in 1971 the shuttle appeared to offer DOD the advantages it sought for a future launch vehicle and a man-in-space program.

Some of the advantages DOD foresaw included the possibility of launching communications, navigation, meteorological, and

reconnaissance satellites while performing the manned military space experiments the Air Force had wanted since the Dyna Soar program. While the design studies for the STS continued, the USAF studied potential defense applications of the system. In the early 1970s, the Air Force still actively sought a manned role in space.

DOD Uses

President Nixon authorized the Space Transportation System in January 1972, with the DOD as a partner in its development. Yet the DOD remained uncertain about what the shuttle might do, besides launch military satellites. In a 1977 House of Representatives Space Science Subcommittee Hearing on the STS, the DOD mission was typified as "conservative," with plans to use only 20% of the total STS missions. Defense Department officials did know, however, that their payloads needed to be flown on separate missions than those flown by NASA, and NASA concurred with this assessment.(46:xi) Even more significant, the Hearings discussed the results of a fleet size capability study conducted by the Air Force and NASA in 1976. The study's conclusions were: 1) a five orbiter fleet was minimum if the DOD was to do away with its expendable launch capability completely, and 2) less than five would not provide operational assurances allowing termination of expendable launchers. More importantly,

the study indicated that less than five in the orbiter fleet would not allow routine use of the expanded facilities on the west coast at Vandenburg AFB, California. It also stated that a fleet of fewer than four orbiters would not permit the DOD or commercial users to commit fully to the STS facility on the east coast. (46:20) This conclusion would return to haunt the Defense Department when Challenger was lost in January 1986.

If five orbiters were approved, the plan called for three orbiters at the Kennedy Space Center (Cape Canaveral) and two at Vandenburg. Less than five, and the Air Force believed it would require a standby expendable launch vehicle capability at the western launch complex "because of the reduced operational flexibility which a reduced fleet size would provide in the event of damage or loss of an orbiter." (46:81) But Congress was unconvinced, and approved four instead of the requested five STS vehicles. The cost of five was simply judged too high. (22:1) DOD and NASA officials began planning space shuttle usage around a fleet of four, with military use of the shuttles devoted to national security missions.

A 1982 White House fact sheet stated that the STS would be the primary launch system for national security and civilian space missions of the United States. (47:108) But the predominant military question in the early 1980's remained: "What exactly is the need for a military man in space, and what should be the space policy to support that need?"

Developing a Military Space Mission

In a 1981 article, the New York Times stated that from the beginning of planning in the 1970's, the shuttle program would benefit from military operations. (22:1) But no one, it seemed, could as yet define exactly what manned military operations in space would embrace. Lieutenant General Daniel O. Graham, USA, attempted to define what these operations should be in his book High Frontier, when he put a top priority on development of a utility-type manned space vehicle capable of satellite inspection, on orbit maintenance, and space tug missions wherever satellites could go. "We can harbor no illusions that space can be limited to peaceful uses. . .," he declared ". . .most current space assets. . .are partially or entirely military [in nature]. . . ." (4:40-41) Obviously, the STS could fulfill some of Graham's missions, but not all of them. Specifically, the STS could not reach satellites in high earth orbits. Graham, therefore, argued for a follow-on to the STS that was capable of accomplishing those missions. This follow-on vehicle would be ". . .a multi-purpose, military, manned space vehicle to perform a wide variety of space missions. . . ." (4:47)

Colin S. Gray considered American space policy in his 1983 book on the military uses of space:

> Notwithstanding a quarter of a century of space experience, the United States today remains confused as to what its space policy should be, how it should think about the military uses of space and how military space activity may affect national military policy as a whole. (5:94)

Gray blamed most of the policy confusion on military planners shortsightedness. He said that planners could not or did not comprehend the dimensions and possibilities of space war, therefore, they dismissed it as an unneeded medium. Gray asserted that military planners and Congressmen were not foresighted enough to realize the potential of space. Space systems, he continued, almost exclusively were developed in response to Soviet achievements that threatened the national pride or well-being. (5:95)

Gray believed that President Reagan might finally have provided the military with a manned mission in space. The Strategic Defense Initiative (SDI) proposed by President Reagan in March 1983 would concentrate military efforts, according to Gray. (5:95)

Air Force Role in Space

When Air Force leaders began to think about military missions for the Space Shuttle, they also had to think in terms of how to best perform those missions. Early in the history of Air Force space operations, officials realized that satellites would need to be in either a high inclination polar orbit; a geosynchronous orbit; or a high inclination, highly elliptical orbit to best serve military requirements. These orbits allow

the satellite to see any point on the globe at sometime, or, at the very least, virtually all land masses in one hemisphere. This was the reason the Air Force wanted a shuttle launch facility on the west coast at Vandenburg AFB, California. Construction of a shuttle launch pad and runway capable of handling the landing shuttle was started at Vandenburg in 1983, with its completion at first planned in 1985. (39:31)

Military secrecy and military control also resulted in beginning construction of a Consolidated Space Operations Center (CSOC) at Colorado Springs, Colorado, in May 1963. (45:31) Some of the STS missions the Air Force expected to control using the CSOC included the repair and/or retrieval of low-earth orbit satellites, manned reconnaissance tests, eventual deployment of a space station, and ocean surveillance, among others. The mission differences between MOL and STS were minor. MOL would have repaired satellites in orbit, the STS could repair in orbit or retrieve and return the satellite to earth for repair before returning them to orbit again. (20:19) CSOC was to control these missions.

The costs associated with CSOC, the Vandenburg launch site, and a military man-in-space role were again hotly debated, much as the costs of a military manned space role had been debated in the past. The debate now centered around the costs of putting man in a system that could probably be automated and do the same job cheaper and with less risk to life. Critics contended that life support systems, the requirement to build and launch a

larger container to accommodate human needs, and the added weight and complexity that man added to the system were not worth the increased costs.

On the other side of the argument, the words also had not changed over the decades. Proponents claimed that man could evaluate events which robots could not, and could react to unexpected events. (9:34) The proponent's problem remained: this argument never defined a role for military man in space except in general and abstract terms. A manned role in space, however, may have been established for the Air Force largely by the SDI program and increasing Soviet capability as demonstrated in the Soyez and Salyut programs.

According to Aviation Week and Space Technology the Soviets helped proponents of a military manned presence in space tremendously, even if unintentionally, through their Salyut space station program by demonstrating the value of manned ocean surveillance, command and control, and testing of their own SDI-type components. This, added to ongoing shuttle experiments, brought reconsideration of the possibilities of and need for a military man in space. (20:19)

The Future

After forty years, a manned role in space is finally gaining support. Two systems have been proposed to fulfill that

role: an aerospace plane and a space laboratory. The aerospace plane appears in two forms, one considered by NASA and the other by the DOD. The NASA concept is already being designated the Shuttle 2 and could be ready for use before the current STS fleet is retired around 2010. NASA planned Shuttle 2 to be ready for flight by the year 2000. This gives the two systems a ten year overlap.

Reviewing the two systems, Aviation Week stated that Shuttle 2 would be a space station logistics spacecraft, made of lightweight materials, using rocket propulsion. Although the new Shuttle will employ a single stage, it will be designed to take off vertically as does the current STS. The primary improvement over STS: Shuttle 2 will carry its own weight in payload into earth orbit. (21:30)

The Shuttle 2 is being considered and designed at the same time as the Air Force's X-30 aerospace plane. The X-30, however, is progressing at a much slower rate than Shuttle 2 because technological breakthroughs are required if the X-30 is to live up to DOD's expectation of a vehicle capable of using a runway for takeoff as well as landing. This aircraft-space vehicle will not be ready for subscale testing until 1993 or 1994 at the current rate of development. It will be well into the 2000s before X-30 will become operationally ready. With such a long development period, and with NASA working on Shuttle 2, the question of duplication of effort will probably surface again as it did with Dyna Soar and MOL, although NASA and DOD both claim

that the missions and technologies will be different. (21:31) This claim, however, has not saved previous Air Force manned space programs.

The second potential use of military man in space resides in a space station, although as late as 1986 the DOD showed little inclination to support a space station. In 1983 the Air Force Scientific Advisory Board, the Naval Research Board, and the Army Science Board conducted extensive studies on the potential uses of a permanent military space presence. The initial results of this study indicated that a manned space station could be used to construct and maintain large, space based, early-warning radars; command, control, and tracking systems; and for laser or directed energy weapon research to support the President's SDI program. (20:19) The USAF Scientific Advisory Board further recommended that:

> military utility of [a] follow-on military dedicated manned space station across the full spectrum of anticipated military activities under various threat environments ranging from peacetime through crises management, third world conflicts, to large-scale conventional warfare. (43:3)

The same year that these groups conducted this study, Brian O'Leary considered space stations and observed:

> [President Reagan's recently announced Star Wars was] not consistent with the Air Force's emphasis on an unmanned program and reluctance to actively promote the space station. . . . The Air Force is more interested in extending what is familiar to them--the unmanned satellite program--into. . .the battlefield. They are not interested in manned flight, in spite of the Soviet push. . . . [The Air Force] appears to be taking a wait and see attitude toward a space station. (10:18-20)

O'Leary went on to remind the DOD and the Air Force of the potential uses of a manned space station, which he was sure the Soviets were taking advantage of in their space program. The potential military uses he claimed for the station included:

> 1) Research and Development. . .a new dimension of warfare. An anonymous military official said: 'The Soviets goal of having continuously manned space stations may support both defensive and offensive weapons in space with man in the space station for target selection, repairs and adjustments, and positive command and control.' At least one contractor. . .emphasized the importance of spending a few years of research and development on military man in space--a dress rehearsal for battles controlled from or carried out in space.
>
> 2) Manned Command Post which is consistent with the Air Force stated long term goal for the 1990s. This will provide confirmation of. . .automated systems which are not always accurate.
>
> 3) Warfare In Space. . .could range from space based lasers or particle beam generators capable of interfering with aircraft, to detecting and reporting enemy troop movements or intercepting enemy missiles. (10:21-24)

Despite this speculation by O'Leary and others, and the recommendations of the Scientific Advisory Board to continue investigations into potential uses of a space station, the Air Force displayed little inclination toward pursuing a permanent manned presence in space. Scientific Advisory Board consultant Eberhart Rechtin expressed his misgivings in 1983 on the validity of pursuing a space station :

> A number of proposals have been circulated for use of a space station for repair, satellite storage, satellite recovery and the like. . . . In concept, all of these things are possible, though not necessarily cost effective. (41:2-1)

Air Force grass roots support for a manned space station was, nevertheless, gaining steam. Aviation Week reported in December 1986 that the Department of Defense had reversed its stand and would now play a part in planning the US and international space station for military research. Apparently the need for SDI space based studies contributed to this decision. Whatever the reasons, it appears the Air Force will actively claim, once again, the need for a manned presence in space.

An Air Force manned space mission, however, has remained elusive. In July 1983 Richard D. DeLauer, Under Secretary of Defense for Research and Engineering, stated in an interview:

> Whether or not any. . .[military space] missions will be better served by a manned space station is problematic. It's not that we haven't tried. Not only in the [unclassified] but also in the [secret] world we established groups who looked very, very hard at whether we can do a better job with man in space, not only in a station but also in the [Space] Shuttle. (22:21)

The Department of Defense over the next few years will need to find a mission for man-in-space if it is to claim a permanent manned space presence. Until a specific mission is designated and the leadership of the Air Force, its sister services and the Department of Defense agree upon that mission, Congress will likely continue to withhold funding for space and cancel programs over budget or duplicate civilian programs. SDI may hold the key to accomplishing that task. If the military

does not establish this need, however, it may be hard pressed to catch up with the Soviets should they develop a true military space mission which threatens the United States' right to use space freely.

CONCLUSION

Since the late 1950s the United States Air Force has attempted with limited success to define a need for a manned military presence in space. In 1958 Air Force leadership thought it had solid justification for the expense and potential hazards associated with manned space flight. Dyna Soar was planned as both an offensive and defensive manned space system with specific roles in orbital reconnaissance, interception and bombardment. Dyna Soar's potential uses in these roles, however, became muddied with President Eisenhower's policy for the peaceful use of space. That policy, still basically in effect, permitted military support missions but eliminated offensive roles for Dyna Soar. Advancing robotics and electronics technology directly affected both defensive and offensive space missions, and led to the cancellation of the Dyna Soar and Manned Orbiting Laboratory (MOL). Consequently, the need for a manned military role in space continued to be questioned by both civilian and military leaders. Proponents of manned military missions, meantime, have been unable to successfully define an overriding need. As early as July 1961, Air Force Chief of Staff Curtis E. LeMay told the USAF Scientific Advisory Board that he could not define a weapon system dependent on the space environment that was manned. But he argued that the Air Force needed to put a man in space to define that role. (45:132-133)

Supporters today still declare: "We need to put military men in space to determine his role in that environment." This theme was repeated on the cancellation of Dyna Soar in 1963 and announcement of the Manned Orbiting Laboratory program. On February 3, 1964, Secretary of the Air Force Eugene M. Zuckert testified before the House Armed Services Committee :

> In the field of military applications of space, our views as to the future remain unchanged. We believe that we must vigorously exploit the most likely avenues of interest, though we are not yet able to be definitive enough to describe man's military space role. . . .
>
> The Manned Orbiting Laboratory (MOL). . .is a research program aimed at giving man the opportunity to operate in space so that we may determine whether and when the manned space vehicle will be militarily significant. (37:44)

Running behind schedule and over cost estimates, MOL was canceled on 10 June 1969, without having determined the elusive role of military man in space. The search for that role continues today with the Space Shuttle. In 1983 USAF Deputy Assistant Secretary for Space Plans and Policy Charles W. Cook declared:

> A great deal of knowledge is needed to determine exactly what the [military] man's role should be. Lacking any specific military requirements that we can identify at this time, the Defense Department currently believes that an evolutionary approach is preferred in determining the operational value of military crews in space. (23:21)

Some might argue that the Air Force manned space niche was indeed found in the Space Shuttle, and that the shuttle mission is all that man can and should do in space. However, placing

satellites in and repairing them on orbit, rather than replacing them using unmanned launch vehicles, may not be cost effective. Although the evidence is inconclusive, opponents of the Shuttle claim that it is cheaper to continue to build new instrumented satellites and put them in orbit with expendable launch systems. In April 1980 Gregg Easterbrook, science writer for a small Washington DC newspaper, observed, ". . .the Shuttle simply can't do anything the old rockets couldn't do, won't save money, and won't help us learn anything we couldn't learn. . .on the old rockets."(9:32) USAF Scientific Advisory Board member Ivan Getting criticized the Space Shuttle versus expendable launch vehicle costs, stating:

> Originally, NASA. . .[believed the Shuttle's] reusability would reduce the cost of transporting satellites into low orbits as compared to the use of expendable launch vehicles. In the early analysis, a large number of launches per year were assumed; and some costs of operating man-rated vehicles were estimated. As a matter of fact, the number of U.S. space launches has fallen. . . . This reduction is due to. . .military satellites. . .[being] more capable and last[ing] longer than 10 years ago. [The result is]. . .the recurring costs to the taxpayer of the manned shuttle is. . .about $150 million as compared to an expendable vehicle launch of about $60 to $80 million. (27:3-5)

If Easterbrook and Getting's misgivings become widespread and the Aerospace Plane does not materialize, the Air Force can expect to return to expendable vehicles when the Space Shuttle program concludes, approximately 2010. The Space Shuttle, however, presents the Air Force with a golden opportunity to find a role for man in space. This opportunity could be

extended if NASA builds a space station, and the Air Force shares the development costs in return for use of the station. Getting believes the Air Force should take that risk because:

> military operational requirement for a manned space station, and while current approaches to space experimentation do not strongly favor the presence of a man in space, the existence of a manned national space station would undoubtedly make some contribution in the development of space facilities technology, research and development of defense-related components, subsystems and sensors. . . . Certainly extending the flight time of the Shuttle would not only extend the usefulness of the shuttle for such experiments but also point the way to more imaginative system experiments. (27:3-8)

Still, doubt of a useful manned space mission remains strong within the Air Force. An unnamed Air Force official bluntly told Aviation Week in December 1986: "We really don't know yet specifically what we would use [a space] station for its high level supporters. Major General John H. Storrie (USAF) recently told an Aviation Week reporter, "Anybody who thinks there's not a role for the military man in space has their [sic] head in the sand." (19:22) But Soviet manned space spectabulars and Air Force advocacy is not enough. Congress must be convinced of an Air Force need for a manned military presence in space before it will provide the billions of dollars to develop and deploy the necessary space systems. If the Air Force wants those dollars, it must do more than claim a need to "take the high ground" in the nation's defense. It must effectively use its current programs to establish a

convincing need for military man in space. Short of that, the perennial question, "What role is there for military men in space?" likely will remain unanswered, and the nation and its military services will continue to rely on automatic instrumented spacecraft.

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